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VOLUME VI
Number 4

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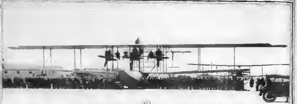

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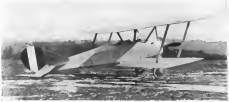

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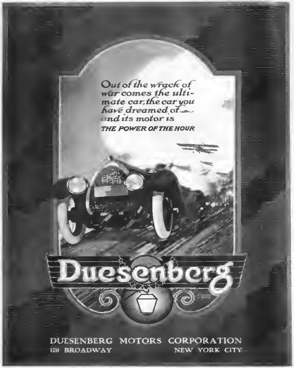
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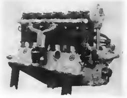

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MARCH 15, 1919

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VOL. VI. NO. 4

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Vol. VI March 15, 1919 No. 4

THE achievement which promises to offer the greatest immediate glory in the field of aeronautical endeavor, and which will perhaps be considered by future generations as the supreme accomplishment of aerial navigation, is the transatlantic flight. To the nation which will succeed in first effecting this great flight, that is, to the constructor of the aircraft and to its crew, there will come a lasting credit. No wonder then, that the prospect of achieving this feat should fire the ambition of many a manufacturer and pilot; what more, this problem has actually outgrown the limits of private enterprise, for two governments at least, the American and British, are officially championing the transatlantic flight.

The project which has the approval of our own government consists in crossing the Atlantic by multi-engine flying boats, either via the direct route to Ireland, or else by way of the Azores. The Navy Department has placed Lieut.-Comdr. John H. Towers, U. S. N., in charge of the organization for the transatlantic flight, and work is actively proceeding on a flottilla of huge seaplanes of the NC-class with a view of putting them in shape for the great venture. Lieutenant-Commander Towers is one of the three naval aviators who were detailed to flying duty in 1911, when the entire naval air establishment consisted but of three land-going airplanes which had been purchased with the initial appropriation of $25,000, his appointment to this important post is indicative of the high esteem the Secretary of the Navy has for the professional skill of this officer who has consistently been connected with air work for the last eight years. His choice augurs therefore well for the success of the Navy's transatlantic flight project.

A similar enterprise is now maturing in Great Britain, where several huge naval flying boats are being prepared for the great venture. These machines are a development of the America, the forerunner of the modern twin-engine flying boats, in which Lieutenant Porte, R. N., intended to cross the Atlantic in 1914 by way of the Azores, when the outbreak of the Great War stopped this project. The British transatlantic flying boats are similar in size and power to our own NC class boats, except that they are triplanes and are fitted with five engines.

A very important point in connection with the transatlantic flight, which holds in store the promise that the ocean will be crossed by heavier-than-air craft from this side before it will from Europe, is that the prevailing winds blow in the northern Atlantic from a western quarter. This applies only to the direct route to Ireland, but in these regions the winds are powerful enough to greatly accelerate the progress of an eastward bound airplane. On the Southern route, which leads through a considerable area of dead calm, only light winds are encountered, and these blow in general from an eastern or north-eastern quarter. Thus, on the face of the problem, the direct route has more inherent assets —apart its greater length—than the Southern route.

The British official project, which is being worked out by the Admiralty, relies beside on seaplanes also on airships for crossing the Atlantic. This seems sensible enough in view of the meteorological conditions the westbound route involves. The British intend to use two or perhaps three rigid airships of the largest size for this purpose; two of these crafts, which have already made their trial flights, are credited with a cruising radius of 8,000 miles, which is more than amply sufficient for the purpose in view. It is believed that these airships will steer the Southern course, by way of Portugal, the Azores and the West Indies, where favoring winds may be met and where strong adverse wind currents are virtually out of the question.

The contest for the first place in the record of transatlantic flight thus becomes a race between all the professional skill and resources the world's two biggest navies can muster, with the United States championing the invention of its sons, the Wright brothers, while Great Britain divides its favors between seaplanes and airships.

It is furthermore possible that France and Italy, too, will enter this great contest, for several airplane manufacturers of both countries have at various times been reported as building machines for the transatlantic flight. Whatever the outcome of the issue, it is certain that the aircraft based on the experience gathered during the war have reached that point of perfection where the crossing of the Atlantic may be looked forward to as a practical certainty during the next few months. When this momentous event will have been achieved, it will mark the beginning before long of transatlantic air travel.

Airplanes at the Aeronautical Exposition

By Alexander Klemin

One of the most interesting features of the Show was the exhibition of various small sporting machines. These include the Gallaudet "Chummy Flyabout," the Dayton-Wright T-4 "Messenger," and the Navy M-2 type seaplane The last was primarily constructed for submarine patrol work, but is certainly a possible sporting machine Two other sporting machines, not actually exhibited, but represented at the Show are the Sperry "Sportplane" and the Aircraft Engineering Corp "Ace."

The designers of three of these planes include an air-cooled power plant in their products, the Lawrance and the Indian motorcycle engines, respectively In the sporting machine, anything which limits or decreases complications is a valuable asset — hence the justifiable use of air-cooled engines.

Gallaudet "Chummy Flyabout"

The Gallaudet "Chummy Flyabout" or more technically the E L2 monoplane, is of striking design. Its weight fully loaded is 1080 lb. and with a wing area of 130 sq ft, the wing loading is 8.3 lb sq ft, which is fairly high, even for a monoplane. The two engines employed are Indian motorcycle engines, with no important departures from their usual form, developing between 18 and 20 hp each and giving the plane a power loading of 27 lb/hp The fuel capacity is 8 gal, giving an endurance at full power of 2 hours The monoplane has a span of 33 ft., a chord of 4 ft 6 in, R A F 15 wing section modified and 2 deg dihedral. Overall length, 18 ft 7 in The tail areas are as follows Stabilizer, 12 sq ft, elevators, 8.5 sq ft; vertical fin, 2 sq ft; rudder, 4 sq ft

The pilot and passenger are comfortably seated side by side, and the vision is good The incorporation of the side by side feature is well justified, for with a dual control installed, the possibility of pleasant, easy, unofficial flying instruction is a valuable thing Flying alone or with pilot and passenger in tandem so that communication is difficult is a lonely business. Seated together, the pilot and passenger, having reached a safe flying altitude, throttling the engine down so as to leave sufficient speed, but saving power and strain on the engine, can really enjoy a joy-ride. Nor would it seem, from a technical standpoint, that the side by side arrangement makes the design of a good shape of body at all a difficult matter

The propeller drive for the two pushers is another manifestation of the tendency to minimize the danger of engine breakdown by employing a twin drive The single transverse shaft is driven by a chain from each engine, and by means of two disk clutches, either of the two engines can drive both propellers In the case of one engine stalling, there is, under these conditions no tendency for a spin, as in the case of twin engines with two separately driven propellers. As an offset to these advantages there is the additional weight and complication of long shafting, two bevel gear systems, etc.

Another interesting point in this design is the extremely low landing gear This permits the wheels to be half enclosed within the boat-like body, with a corresponding decrease in resistance On rough landings, however, the low landing gear entails somewhat the risk of the wing tips striking the ground

The Dayton-Wright "Messenger," a biplane tractor, is of much more conventional design It is equipped with a 2-cycle, 4-cyl air-cooled "V" type De Palma engine, weighing 3.7 lb/hp, with a fuel consumption of 4 gal per hour With a total area of 106 sq ft the plane fully loaded weighs 636 lb, which is not too high a wing loading, although it is still far from the ideal wing loading of a sporting type The speed range is given by the manufacturer as 37-85 m.p.h and the engine develops 37 hp at 2,000 r.p.m. The weight empty is 476 lb., with a gasoline supply of 12 gal. The single seater cockpit is comfortable and roomy The overall length is 17 ft 8 in., the span 19 ft 3 in, height 6 ft. 1 in

It has a certain family resemblance to the DeHaviland planes, in landing gear, attachment of wings to center, section etc One or two interesting features are present Single cables are used for both flying and landing wires, streamlined with rubber fairing The fuselage consists of longerons, veneer sides and wood strips in lieu of wires

The Navy M-2, designed and built by the Loening Engineering Corp, is certainly the smallest seaplane in existence. It is a tractor monoplane of simple construction, with an overall length of 13 ft, a span of 19 ft, and a chord of 4 ft, the wing area is 72 ft Equipped with a Lawrance 3 cylinder 60 hp engine, and carrying a pilot and 12 gal. of gasoline, sufficient for 2 hours' flight, it weighs 500 lb

An interesting departure is the use of aluminum floats, which insures extreme lightness of construction With a narrow chord, the vision—always a difficult problem on a monoplane—is excellent The construction is very simple and the bracing of the wings and pontoons is extremely logical

For the Sperry "Sportplane," nothing but the specifications is at present available, and it is interesting to include them here as an advance note The "Sportplane" is a twin engine tractor biplane provided with folding wing arrangement, it is 27 ft. in span, with wings extended 13 ft 4 in with wings folded, and its overall length is 21 ft. Owing to the folding wing arrangement the dimensions of this machine are kept at such low figures as to make the housing problem an easy one, while on the other hand the twin power plant obviously insures greater reliability than a single engine. These features are of considerable value in the development of civil flying, and the trials of the "Sportplane" should be followed with great interest The power plant consists of two 2 cycle 4-cyl air-cooled de Palma engines, each of which develops 37 hp, and drives a tractor airscrew of 5 ft ft in The flying weight is 1,050 lb, the weight empty, 576 lb., the wing loading is 4.5 lb sq ft and the power loading 14 lb The speed range is given by the manufacturer as 36 to 88 m p h The seating arrangement is of the tandem type

The Aircraft Engineering Corp calls its product the "Ace" This machine is equipped with a 40 hp 4-cyl. engine, cast en bloc, and a tubular aluminum radiator placed directly beneath the center section It has a span of 28 ft 4 in, lower wing 22 ft 10 in The landing gear has a hickory skid between the wheels, which is useful in a sporting machine

Constructors have apparently given much thought and care to the small machine, and there is undoubted evidence of a sound development, which will meet a popular demand for this type of airplane It may be safely said that the small single-seater sporting airplane is already reaching a point of practical utilization

A Side-by-Side Machine

The Thomas-Morse side-by-side two-seater, a little larger than the small sporting machines, is an interesting type,

which has been designed particularly for civilian use, with ample seating room abreast The cockpit is lined throughout, with the control wires beneath the floor This is one of the best examples of the tendency to adopt planes to civilian usage With a total weight of 1,530 lb., a length overall of 21½ ft., a spread of 32 ft., height 9 ft., the plane has a high speed of 90 m p h and climb 6,700 ft. in the first ten minutes

Advanced Training and Fast Sporting Types

Two machines stand out definitely in this class,—the Vought VE 7 and the new Packard two-place tractor

The Packard has the Lepère touch in its design, with the peculiar interplane veneer framework replacing the usual interplane struts and wiring—a type of construction which has amply justified itself Finished in appearance, but conventional in design, the Packard is mainly of interest because of its excellent new engine, and the wonderful engine mounting The carburetor has its air intake protruding through the lower part of the body, thereby precluding risk of fire The accessibility of the engine is complete and serves as an example of what can be done in this direction By opening small doors, it is quite possible to get at the carburetor, the ignition or the water pump with a minimum of trouble. The engine mounting is an interesting departure from the usual, consisting of two channeled plates on either side, carrying the engine bearers at their center, and solidly attached to the end of the body The aluminum cowling can be easily detached, and carries a great many louvres for the passage of air from the radiator The engine mounting is truly interesting as an example of what can be done with skilful design The main data for the machine, the performance being solely an estimate, is Length 25 ft 0 in, width 37 ft, height 8 ft 11 in, weight, empty 1,520 lb, gasoline supply 44 gal Maximum speed 102 m p h Climb 15,000 ft. in 34.5 min

The Vought VE-7 tractor biplane, commonly known as the Blue Bird from the painting of the cowling, is a beautifully finished job Fully loaded to 2,000 lb., the maximum speed is close to 110 m p h with the Hispano Suiza 150 hp engine. Main dimensions are Span 34 ft. 3 in, height 8 ft. 7½ in., chord 4 ft. 7½ in., dihedral 1¼ deg Wing area 297 sq ft, stabilizer 19 sq ft., fin 2.3 sq ft, rudder 7.8 sq ft; ailerons 37.42 sq ft., elevators 17.09 sq ft

It is remarkable what performance has been attained on this machine with purely conventional design, refined to a high degree. As a useful example of refinement, the main plan fittings are enclosed in the wing, and the strut sockets are designed flush to the wing surfaces. The machine handles remarkably well in the air, and is most sensitive to control On sand test a factor of safety of 9 was obtained. The machine in general appeals strongly to both eye and judgment

These two machines are certainly interesting from a sportsman's point of view, though the Vought would be a machine for a really first class pilot, not an amateur.

High Speed Machines

Another interesting feature at the Show is the presence of machines with such extraordinary speed and climb that the public is at first inclined to look askance at the fully justified claims of the manufacturers Three machines may be included in this category the Loening two-seater monoplane, the Thomas-Morse M-B-3 Scout and the Christmas Bullet Speeds round and about 150 m p h. have been attained without any increase in power over those employed during the war, by refined structural and aerodynamic design It is, indeed, a wonderful showing for American designers

Curtiss 18-B Biplane

The Thomas Morse M B-3 is a single-seater fighter built round the 300 hp Hispano-Suiza engine It is of fairly conventional design, with the well-known Spad truss, which seems to be a very happy compromise between the type with one pair of struts on either side and unduly heavy spars, and the type with two pairs of struts on either side with the ordinary wire or cable trussing The main dimensions are Length 19 ft 0 in, width span 26 ft, height 8 ft 0 in tractor biplane The weight empty is 1,360 lb, the gasoline supply, ample for a machine of this type, is 65 gal, and the gross weight is 2,050 lb The power loading is thus less than 7 lb hp, and this, together with the cleanness of the design, fully explains the maximum speed of 163 m p h and the climb of 10,000 ft in 4 min 52 sec

One very interesting deduction in the design of fast airplanes is that it is possible to employ either a monoplane, a biplane or a triplane, and obtain equally remarkable results Thus we have the Thomas Biplane with a speed of 163 m p h, the Curtiss Triplane with a speed of 151 m p h, and the Loening monoplane with a speed of 145 m p h

The Loening monoplane, well known by now, achieves a *tour de force* in obtaining such high performance with high useful load, two men, full armament and ample gasoline supply The monoplane also carries with it the advantage of simplicity—clearly seen on a cursory examination at the Show

The Christmas Bullet of the Cantilever Aero Co, presents a great many curious features. Though perhaps fully official figures are not yet available, yet there is no doubt that its speed and climb are extremely notable The main point of interest is the biplane structure without interplane bracing The wings are not of extreme thickness and taper towards the tips. There is no doubt that metal reinforcement of one character or another is employed The wings are of flexible construction. As regards safety, the construction of this machine

still remains to be demonstrated. The very high body, not aerodynamically advantageous, is necessitated by the trussless construction.

The figures for these machines lead one to believe that speeds of 200 m.p.h. are not far distant.

A Fighting Ship of the War

The DeH4 is there and is beheld with a sort of gentle melancholy by those who watched its glorious work during the war. Once rated as a high speed fighting machine, it still makes a fair showing, but how far outdistanced by the high speed machines just dealt with! The Dayton-Wright exhibit a model of the Honeymoon Express, which is a modification

10 in.; gap 8 ft. 6 in.; wing area 1,070 sq. ft. It has a maximum speed of 114 m.p.h. and a climb of 10,000 ft. in 15 min. The structural work of the Glenn L. Martin is really a lesson in design, in rugged and robust construction. The bracing of the two engines to the central nacelle appears logical and correct to the eye. The landing gear is very skilfully disposed, so that there is one wheel directly under each engine and two wheels under the central fuselage. The tunneling of the bottom of the body to permit the mounting of the lower gun has introduced difficulties in trussing which have been solved in a simple and light manner.

Beside the Glenn L. Martin, the Caproni, in spite of its excellent service during the war, looks somewhat fussy and

INTERIOR BODY VIEW OF THE NAVY F-5-L

of the DeH9 with provision for two passengers, side doors, moveable chairs, etc. It is satisfactory to think that at least the DeH4 is doing useful work in the mail service.

Multi-Engined Machines

The exposition was particularly well favored in showing three multi-engined machines, all of the night-bombing types—the only important night-bombers built or rebuilt in the U. S. A. during the war—the Handley-Page, the Glenn Martin and the Caproni. The American ship shows up very much better than the two foreign machines, but all three have an excellent appearance and are quite obviously an introduction to commercial transportation.

The Glenn L. Martin twin engine machine, built during the war to fulfill the requirement of night and day bombing and long distance photography, is certainly well adapted for passenger or mail service, a load of one ton of mail or of twelve passengers being well within its power. With a gross weight of 9,663 lb., it has the following main dimensions: span 71 ft. 5 in.; chord 7 ft. 10 in.; overall length 46 ft.; overall height 7 ft.

unrefined. The fittings to an American eye look clumsy. Of course, it must be remembered that this machine is of considerably older design than the Martin.

In the Handley-Page, the designer has preferred to carry one body rather than have the extra structural complications of the two Caproni bodies. One is impressed by the extent to which the fuselage extends forward of the wings, providing the best possible vision for the pilot and gunner. The immense steel tubes in the landing gear are also impressive. The hinging back of the wings does much to do away with the difficulties attendant on the use of machines of such a large span.

The weight of the machine fully loaded is 14,400 lb. The wing area is 1,650 sq. ft., with two Liberty-12 engines, the power loading is 18.0 lb./hp. The maximum speed of the Handley-Page as an offset to its higher useful load, is considerably less than that of the Glenn Martin, being only 94 m.p.h.

These three machines are worthy of much careful study by anyone interested in aerial transportation. Capable of carrying ten or more passengers with part of the power plant out of commission, and having a much greater range than the smaller single seater and two seater machines, the multi-engine airplanes have decided possibilities.

Italian Impressions

Beside the Caproni already dealt with in connection with the multiple engine machines, two Italian machines are exhibited, namely, the SVA and the Balilla. The characteristic features of these two machines are the rigid tubular trussing of the wings and the special form of the body. This passes from a rectangular to a triangular section, which gives a very efficient aerodynamical form. The bodies are built of wooden longerons, plywood bulkheads and veneer sides, and form a most beautiful example of veneer construction. The Warren truss construction in the wings cuts down head resistance, allows cables to be dispensed with and avoids frequent regulation. The Italians have made a careful study of streamline strut construction, and their benchwork deserves considerable attention.

Flying Boats

One of the most salient impressions of the Show is the presence of many flying boats, some of huge proportions. The Navy F-5-L is a huge and impressive twin engine machine. With one side of the wings uncovered and the boat hull stripped of its veneer covering, it is a most interesting and instructive exhibit. The armament is not the least remarkable feature of the F-5-L. A 9-pdr. Davis Q-F non recoil gun in the bow of the boat and eleven Lewis guns form a very effective armament. The flying boat is equipped with two tractor screws, and has the following dimensions: length overall 49 ft. 4½ in.; height 18 ft. 9¼ in.; chord 8 ft. 0 in.; gap 8 ft. 10½ in.; total wing area 1,397 sq. ft. Weight empty 8,250 lb., and useful load 4,750 lb. It has two 330 hp. Liberty engines, with a maximum speed of 87 m.p.h. and an endurance of 7.9 hr. The F-5-L seems really useful, not only for submarine patrol and navy convoy services, but also for civil and commercial purposes.

The Curtiss Co. exhibits its Model M F and the H-16-A flying boats. Model M F, a sport flying boat, is the smallest of the Curtiss flying boats and, at the same time, one of the most popular. It is a "pusher" type with the propeller and engine located in the rear of the pilot's seat. It has a wing-span of 49 ft. 9⅜ in., is 28 ft. 10 in. in length, and 11 ft. 9⅜ in. in height. It weighs 1,800 lb. empty, and will carry a useful load of 636 lb. It is driven by a Curtiss OXX 100 hp. engine or the new K-6 150 hp. engine. The H-16 A flying boat is driven by two 400 hp. Liberty engines. Two guns and a gunner are carried at the bow and behind them are two pilots. In the rear part of the boat, two guns are arranged to be fired through windows in either side of the hull. It will carry 3000 lb., over one-third of which may be left free for passengers, exclusive of the crew. It will prove of ideal size and speed for passenger traffic.

Another exhibitor of a sporting flying boat is the Aeromarine Co. Their Model 50 should particularly appeal to sportsmen owing to its comfortable equipment, with the cabin closed in by a transparent hood. The power plant is an Aeromarine 6-cyl. 130 hp. type L engine. The overall dimensions are: length 25 ft. 6 in., width 48 ft. 4 in., and span of

CURTISS MF FLYING BOAT

upper plane 48 ft. 4 in.; of lower 37 ft. 4 in., with a chord of 6 ft. 3 in. and stagger of 12 inches. Weight of machine empty is 1,925 lb. and when loaded it is 2,500 lb. Landing speed of 46 m.p.h., maximum speed of 80 m.p.h.; time of climb 2,900 ft. in 10 min. It is a sporting machine pure and simple.

A flying boat which has been developed mainly for coast patrol work but nevertheless embodies great commercial possibilities is the HS-2-L of the L. W. F. Co. As fitted for naval service, this machine carries two pilots, a gunner, a machine gun and four large bombs. It is powered with a 360 hp. Liberty twelve-cylinder engine and has an endurance at full speed of 4 hr. It has a span of 75 ft., a weight, empty, of 4500 lb. and carries a useful load of about 2200 lb. A machine gun is placed on a flexible mount in the gunner's cockpit; the four bombs are placed under the wings. A special bomb sighting apparatus is also mounted in this cockpit. It is equipped with a complete radio outfit and dual control. This machine is equipped with a complete set of specially designed Naval instruments, including gyroscope compass and lights for night work. Fully loaded it has a speed range of from 45 to 91 m.p.h. and a climb of 3000 ft. in 10 min.

Seaplanes

Among the many interesting seaplanes at the Show, the Boeing seaplane C-1-F deserves somewhat more lengthy notice, as it has not been fully described hitherto. A biplane two seater tractor, it is an advanced modification of the Boeing type "C" seaplane used by the Navy Department for training purposes during the recent war. A single float only is employed, and the power plant carries the Curtiss OXX-2 8-cylinder engine. The dihedral has been increased to 2¾ deg. The wing structure has the Boeing characteristic of a 50 per cent stagger and 2½ deg. décalage, which helps in maintaining longitudinal stability. The center cabane struts are made of seamless steel tubing with special steel terminals, giving a simple, efficient and sturdy center section construction. The forward construction of the cabane eliminates fore and aft stays, and furnishes substantial means of bracing the side radiators. Wing tip floats are provided of conventional form and securely braced to the lower wings.

The underwater lines of the central float provide quick get-away and easy landing without spray or water disturbance and the machine is stable in get-away, landing and taxying

even in rough seas, with winds as high as 30 m.p.h. The float is of two-ply laminated construction, and with cotton and marine glue between the laminations. The external float fittings are such as to facilitate rapid assembly.

The body is of the conventional longeron truss type with metal frames for engine bearers. The seats are made from a

Liberty, it has a maximum speed of 130 m.p.h. and a climb of 8,100 ft. in 15 min. For a heavy seaplane this is just as wonderful as 150 m.p.h. of the fast land machines.

Another notable type of seaplane is exhibited by L-W-F Engineering Co., Model VH-1. It is similar to Model V-2 of the same manufacturer, but is equipped with pontoons

Thomas-Morse MB-3 Single-Seater Fighter

series of ash slats, conforming to the altitude of the occupant and covered with detachable upholsters. The cushions are stuffed with Kapoc and are readily detachable for use as life preservers in emergency. The Dep. dual control includes an adjustable rudder and adjustable rudder compensation for distance service.

The main data on the machine is as follows: wing area 494 sq. ft., aileron 36 sq. ft., elevators 30 sq. ft. (no stabilizer is employed in view of the longitudinal stability provided in the stagger décalage). Rudder 12 sq. ft., vertical fin 6 sq. ft. The span of the upper wing is 42 ft. 11½ in., span, lower wing, 42 ft. 11½ in., chord 69 in., gap 72 in., length overall 27 in., height overall 12 ft. 11½ in., dihedral 1 deg., stagger 29½ in. The performance is satisfactory: climb to 1800 ft. in 10 min., maximum speed 70 m.p.h., landing speed 48 m.p.h., endurance at full speed 2½ hr., weight fully loaded 2445 lb.

The Gallaudet D-4 is another example of the single pontoon type of seaplane. The most interesting feature in the machine is the propeller drive, which is formed by a long shaft from an engine, placed in the front end of the body. This has the advantage of placing heavy weights in front and not in a dangerous position behind the pilot, while at the same time with the pusher screw extra slip stream resistance on the fuselage is avoided. The Gallaudet D-4 really makes a wonderful showing. With a gross load of 5,450 lb. and a 12-cyl.

instead of landing gears. There are two main pontoons but without any wing floats. It is provided with a 140 hp. Sturtevant engine, which is of air endurance. The body is of the monocoque type. Single control is installed in the rear cockpit. The high speed is 85 m.p.h. and the low speed is 42 m.p.h. The climb is 3,500 ft. in 10 min. The weight fully loaded is 2,700 lb., with a total wing area of 400 sq. ft. It has a useful load of about 1,000 lb. and would be ideal for a water express route or for a sporting machine.

The Curtiss HA seaplane is distinguished by a high speed of 130 m.p.h., which speaks for itself. It exhibits a rather large body permitting a free flow of air behind the radiator, and also the installation of the gasoline tank right under the engine, the consequent massing of weights influences the manoeuvrability favorably.

General Impression

A general comparison with the Show of 1917 indicates progress in size and performance, as well as a general trend toward specialization. The main features of construction remain the same. While there is greater structural refinement aerodynamically, the machines are not much cleaner looking. Follow through in stresses is in general more logical. More attention is given to the pullman machine, and there is not a shadow of a doubt that immediate civilian application in a great many directions is immediately possible.

Aeronautical Patents

ISSUED JAN. 7, 1919

1,290,192—To Nelson W. Dalton, Buffalo, N. Y., assignor to Curtiss Aeroplane and Motor Corp. Landing gear construction.

1,290,230—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane and Motor Corp. Tail skid for aeroplanes.

1,290,348—To James William Ralph, Chattanooga, Tenn. Airship.

1,290,350—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane and Motor Corp. Frisking.

1,290,485—To Anthony Anzer, Washington, D. C. Aeroplane.

1,290,486—To James F. Jones, Akron, Ohio, assignor of one-third to Shelby F. Wallace, Akron, Ohio. Airplane.

1,290,547—To Geo. C. St. Louis and Luigi Pearson, Fresno, Cal. Airship.

1,290,549—To Harry Garden, London. Airship.

1,290,811—To Albert John Fattersen, Randwick, near Sydney, New South Wales, Australia. Aerial machine.

1,290,669—To Harry W. Schmidt, New York. Aeronautical apparatus.

1,290,788—To Joseph Edgar Smart, Hillsboro, N. J. Life saving device for aircraft.

1,290,829—To Warren S. Eaton, Plainfield, N. J. Aeroplane.

1,290,849—To John W. Miller, Seattle, Wash., assignor to Boeing Aeroplane Co., Seattle, Wash.

1,291,012—To Joel Walter Williams, Fort Worth, Tex., assignor of one-half to H. Kilander, Fort Worth, Tex. Aeroplane.

1,290,848—To Jens Joseph Harrey, New York. Aeroplane.

1,290,872—To Swan H. Wiseman, Rochester, N. Y. Aeroplane.

1,290,217—To Henry Kleckler, Hempstead, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Engine frame mounting.

1,290,... To Henry Kleckler, Buffalo, N. Y., assignor by mesne assignments to Curtiss Aeroplane & Motor Corp., Buffalo, N. Y. Aeroplane construction.

1,291,... To John W. Miller, Seattle, Wash., assignor to Boeing Aeroplane Co., Seattle, Wash. Fitting for airplane.

1,290,852—To Wm. I. Hildorge, Flushing, N. Y., assignor to American ... Airplane structural element.

ISSUED JAN. 14, 1919

1,291,098—To Frederick Barlow, New York. Alighting and launching gear for aeroplanes.

1,290,975—To Peter F. Griffiths, New York City. Balloon, airship and other buoyant bodies.

1,291,070—To John R. Kammerer, ... assignor to the B. F. Goodrich Co., New York City. Pneumatic tire structure.

1,291,090—To William Rittersdorf, Chicago, Ill. Airship.

1,291,200—To William P. Robertson, Liverpool, England. Wing plane of flying machines.

1,291,070—To Samuel Karow, Seattle, Wash. Aeroplane.

1,291,334—To Anthony Grant Ambrose, San Diego, Cal. Airship.

1,291,428—To James Robertson, Tyne, London, England. Aeronautical machine.

1,291,467—To John I. Reynolds and Arthur H. Jenkins, Rutville, Miss. Captive balloon.

1,291,294—To Alexander Blair, Thaw, New York City. Aviation for aeroplane stabilizers.

1,291,078—To Henry Kleckler, Buffalo, N. Y., assignor to Curtiss Aeroplane & Motor Corp. Wing construction.

The USD-9A Airplane

The signing of the armistice found the Airplane Engineering Department ready to deliver for production an airplane, the USD 9A, which met the requirements of the Air Service both as a day bomber and as a reconnaissance machine, at the same time harmonizing fully with the Liberty engine, and was entirely suitable for quantity production by American methods.

Speed and Climb Performance

Altitude ft.	Reconnaissance Speed m.p.h.	Reconnaissance Time	Day Bomber Speed m.p.h.	Day Bomber Time
0	126	0	121	0
6,500	120	9' 13"	110	12'
10,000	118	16' 40"	114	22'
15,000	107		85	
Service Ceiling		17,000 ft.		14,300 ft.

Three-Quarter Front View of the USD-9A

The following very complete data are now available on this machine, which is a two-seater tractor biplane.

Main Dimensions

Overall length 30 ft. 2⅝ in.
Overall height 10 ft. 4 in.
Height of propeller axis above ground, machine at rest 7 ft. 2 in.
Height of propeller axis above ground with plane in horizontal flying position, 7 ft. 9 in.
Total wing area including ailerons, 490 sq. ft.
Wing section combination R. A. F. 14 and 15
Upper wing area 251 sq. ft. (including center section)
Span, upper wing 45 ft. 11 in.
Chord upper wing 5 ft. 9 in.
Lower wing area 239 sq. ft.
Span, lower wing, 45 ft. 11 in.
Chord lower wing 5 ft. 9 in.
Gap 6 ft. 1½ in.
Stagger 12⅝ in.
Sweepback none
Décalage, none
Dihedral 3 deg. for both wings.
Aileron area (4) 72.28 sq. ft.
Stabilizer (adjustable) area 31.06 sq. ft.
Stabilizer setting to lower wing chord 0 deg. 30 min. positive to 3 deg. 40 min. positive
Elevator area 23.64 sq. ft.
Fixed vertical fin 7.21 sq. ft.
Rudder area 13.71 sq. ft.

Factors of Safety for Wing Truss

Low speed, by stress analysis 7.74
High speed by stress analysis 5.36
Sand load test 6.7

Power Plant

Standard Liberty 12, 400 hp. at 1700 r.p.m.
Propeller 9 ft. 10 in. dia., 8 ft. 3 in. pitch. Two blades
Fuel consumption 0.504 lb. per b.hp. hr.
Oil consumption 0.0371 lb. per b.hp. hr.
Main fuel tank capacity 114 gal.
Reserve fuel tank capacity 5 gal.
Oil supply 90 lb.
Fuel weight 842.6 lb.
Water carried 127 lb.
Cooling area of honeycomb cell core about 2½ sq. ft.

Armament

Machine guns. Forward one fixed Browning gun with synchronized gun control and 750 rounds of ammunition. Rear cockpit two parallel flexible turret Lewis guns, 970 rounds of ammunition.
Six 50-lb. wing bombs and two 110-lb. fuselage bombs.

General Equipment

Wireless sending and receiving apparatus (reconnaissance machine only)
Photographic equipment (reconnaissance machine only)
Interphone system
Very signal pistol and cartridges
Two oxygen apparatus
Electrically heated clothing
Fire extinguishing apparatus
Usual instruments.

Weight Distribution, Wing Loading and Power Loadings

	Reconnaissance	Day Bomber
Weight with full load	4521 lb.	4987 lb.
Load per sq. ft.	9.23 lb.	10.18 lb.
Load per hp.	11.30 lb.	12.47 lb.
Weight Distribution—		
(a) Structural weight including wing truss, fuselage seat control and engine mounting control surface and landing gear.	31.7%	28.9%
(b) Power plant including water, tanks piping exhaust manifold and propeller	31.6%	28.9%
(c) Military load including passengers, guns and all equipment	16.4%	25.4%
(d) Fuel and oil	20.3%	18.8%

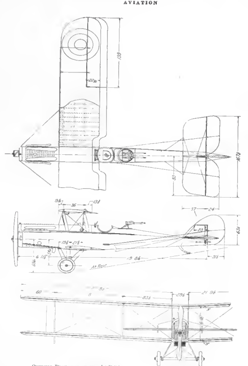
Body

The USD-9A body is of modified truss design of rectangular section, in which veneer side panels are used for the greater portion of the length over a framework of longerons and struts, the veneer is stiffening the construction somewhat and thus eliminates some of the usual internal bracing. The body is made in two sections so that the rear end, carrying the empennage and tail skid, is detachable. The two parts are secured to one another by butt-joints in the longerons, reinforced with gusset plates, aft of the gunner's cockpit.

The weight of the body complete including engine bearers, rudder bar supports, etc., is 340 lb.

The overall length of the body is 25 ft. 10 1/16 in. And its dimensions at the largest cross section, just forward of the pilot's cockpit are 35 19/32 in. deep by 28 11/16 in. wide. The forward portion of the body is thoroughly stiffened by a system of vertical and diagonal struts, to take the various stresses imposed by the engine, and the weight of the fuel tanks, etc.

The material used in the four longerons is ash, with the exception of a portion of the lower longerons, extending from the front landing gear strut attachment to the rear of the pilot's cockpit, this section being of spruce. The longerons are 1¼ in. square, with the exception of the spruce portions, which are 1¼ in. wide and vary from 1¼ to 6¼ inches deep. The longerons are lightened somewhat between the struts in the rear end of the body, by routing out the under side of the top pair and the upper side of the lower pair. Three-ply veneer is used of total thickness 3/32 in., two outer plies of mahogany



OUTLINE DRAWINGS OF THE USD-9A

running longitudinally and a poplar-core with transverse grain, each ply being 1/32 in. thick. Owing to the use of the veneer sides, very little wire bracing is employed as far back as the rear cockpit.

Wing Structure

The wing section employed in the USD-9A is a development of the RAF-15 type, but made slightly deeper at the spars, and with the camber somewhat reduced. The wings are built up in conventional manner with two solid spars of spruce, routed out between compression ribs. The front spar is 4 in. deep by 2½ in. wide, the rear spar is 3 21/32 in. deep by 2⅝ in wide. The spars are spliced at mid-length with a 10 to 1 plain scarf splice with seven ash dowels staggered, taped throughout its entire length. The wing ribs are made of three-ply veneer 5/32 in. thick, with a poplar-core 3/32 in thick with longitudinal grain, and outer face plies of birch 1 32 in thick, with the grain vertical

Empennage

The empennage is of a familiar type of construction, ample strength and light weight and calls for no special comment

Undercarriage

The undercarriage consists of two pairs of solid spruce struts of streamline section supporting a streamline axle through rubber shock absorbers of the usual design. The wheel tread is 6 ft. Standard 64 spoke wire wheels are used, covered with fabric disks and carrying 750 by 125 mm. airplane tires. It has a complete weight of 149 lb

Cooling System

A nose radiator is fitted with a core of the usual honeycomb type, with a frontal area of 5 34 sq ft., and a total cooling surface of 178 0 sq ft. The weight of the nose radiator is 95 lb and it carries 63 lb of water. Running entirely around the outside of the nose radiator core and its upper and lower headers is a separate compartment, ⅞ in wide and of the same depth as the core which acts as an expansion chamber for the cooling system. A set of horizontal aluminum shutters is mounted across the front of the nose radiator. These are set in any desired position by the pilot by means of a double Bowden wire control and a small ratchet lever, mounted on the right side of the cockpit

Mounted in a vertical rack to the rear of the engine and transversely to the body is an adjustable booster radiator, which is connected in series with the nose unit. The auxiliary radiator may be lowered to project 9⅛ in. below the bottom cowl of the body or drawn up into the body until only the edge of the lower tank is exposed. The overall dimensions of this unit are 24¾ in. width by 12⅝ in. height with a core thickness of 4 in. Its effective frontal area is 1 23 sq ft and the total cooling surface is 41 sq ft. It weighs 24 lb. empty and has a capacity of 13 lb of water

THREE-QUARTER REAR VIEW OF THE USD-9A

Gasoline System

A special gasoline system developed at McCook Field is used on the USD 9A. The main supply tank has a capacity of 134 gal with feed to the carburetors by means of two Vane gasoline force pumps, driven from the crankshaft by flexible shafting; and an 8-gal, gravity tank, located in the center section of the upper wing span

While the USD-9A has been designed for the purpose of filling the want of a convertible two-seater fighter, reconnaissance and day-bomber machine of high performance, this airplane is also applicable to the demands of aerial transportation. The British counterpart of this airplane, the DH-9A, has actually been fitted with passenger accommodations, as may be seen in one of the accompanying illustrations, and is being employed in the so-called Conference Mail service, which carries important personages and government dispatches from London to Paris and back.

PASSENGER COMPARTMENT OF A DH-9A, THE BRITISH COUNTERPART OF THE USD 9A

British Air Force Strength

According to a report made public in London, in August, 1914 the British naval and military air services together numbered only 285 officers and 1853 men of other ranks. In November, 1918, there were 30,000 officers and 264,000 men. At the outbreak of the war Great Britain had 166 airplanes, forty-five seaplanes and seven airships, while at the close of hostilities she had 21,000 airplanes, 1300 seaplanes, and 103 airships. Besides this, there were 25,000 airplanes and seaplanes being built and 55,000 airplane engines under contract.

The Women's Royal Air Force, which was not in existence in 1914 numbered at the close of hostilities 23,000.

Characteristics of American Aircraft Engines

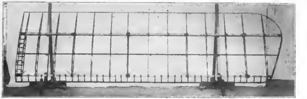
ENGINE	No. of Cylinders	[illegible] H.P.	[illegible]	Cooling	R.P.M.	H.P.	R.P.M.	H.P.	Gear Reduction Ratio	[illegible] Consumption: Lbs. Per H.P. Per Hr. Gasoline	Oil	Lbs. Per Hr. Gasoline	Oil	Weight Dry with Ign and Carburetor in Lbs.	Weight of Cooling Water Lbs. In Engine	In Radiator	Weight of [illegible] Lbs.
[illegible]maine L-6	[illegible]	150	Vert	W	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		66		405			
Curtiss OX2	8	85	V-90	W	1400	85			None					375		24	
" OXX2	8	100	V-90	W	1400	100			None	51	[illegible]	91 2		423	44		46
" OXX3	8	100	V-90	W	1400	100			None								
" OX5	8	100	V-90	W	1350	91	14[illegible]	100	None	53	033	52 8		445			
" VX	8	160	V-90	W	1400	160			None	575	0328			645		92	
" VX3	8	200	V-90	W	1400	200	1900	248	None	73	031			667		70	
" K-6	6	150	V-60	W	1700	150			None	55	03			417			
" K-12	12	400	V-60	W	2330	425	2600	450	1.66 1	50	03			663[1]	38		
Duesenberg A4	4	125	Vert.	W	2100	125	2200	140						450			
" H	16	800	V-45	W	1400				1.33 1					1575			
Gnome Gen V	7	80	Rotary	A													
	6	100	Rotary	A	1200	100	1250		None	72		79 2	18 3	272			
	6	150	Rotary	A													
Hall-Scott A7	4	90	Vert.	W	1300	85	1400	93	None					410	34		
A7a	4	100	Vert	W	1200	100	1400	110	None	557	045			456			
A5	6	125	Vert.	W	1200	128	1400	130	None	58	032			592	52	91	42
A5a	6	150	Vert.	W	1200	152	1400	165	None	565	025	91 8	5 2	578			
L4	4	125	Vert	W	1650	125	1700	135	None	598	054	72 6	6 5				
L6a	6	200	Vert	W	1700	200				55				500			
A8	12	450	V	W										800[1]			
Hispano-Suiza A or I	8	150	V-90	W	1500	155	2000	200	None	51	031	77		455			
" E.	8	180	V-90	W	1500	173	2000	230	None	52	052	102		[illegible]			
"	8	200	V-90	W	1500	163	2000	210	1.33 1	525							
"	8	220	V-90	W	1500	168	2200	238	1.33 1	53		112					
" H	8	300	V-90	W	1700	317	2000	350	None	586	025	168	7 14				
" H	8	300	V-90	W	1700	325	2000	358	None	54	03			[illegible]			
King Bugatti	16	410	Vert	W	2000	410			1.445	583							
King	12	550	V-45	W	1800	550	1435	600	1.445 1	52	14			[illegible][1]			
Lawrance L-1-60	3	60	Radial	A	1400	50	2100	63			15			132			
Le Rhone	9	80	Rotary	A	1250	91	1300	93		60	12			200			
" Alum Piston	9	110	Rotary	A	1250	130	1300	131						330			
Liberty A.	12	400	V-45	W	1630	380	1800	430		52	032	196	12 2	845[1]	46	76	
" C	12	400	V-45	W	1800	420	1950	435		52	032	218	14 0	1000	46		
" "4"	4	125	Vert.	W	1600	136	1600	148		51							
" "6"	6	200	Vert.	W	1400	185				55							
" "8"	8	275	V-45	W	1600		1750			52	03						
Packard 1-A-744	8	180	V-90	W	1525					52				560	25	27	
Sturtevant 5A	8	140	V-90	W	2000	140		170	1.66 1	55	14		8	500	33		
" 5A-4½	8	210	V-90	W	2250	210		240	1.66 1	55	14		8	480[1]	28		
" 7	12	300	V-90	W	2000	300			1.66 1	55	14			900			
Thomas 88	8	150	V-90	W	2000					50	053			525			
Union	6	125	Vert.	W	1400	125			None	558	02	67 0		485			
Wisconsin	6	140	Vert	W	1380				None	55	027			637	28	25	
	12	250	V-60	W	1200				None	602	129			1000			47

[1]For Engine Only

ENGINE	Weight of Sample Accessories LBS Radiator	Propeller	Mounting	Cowling	Bore Inch	Bore M/M	Stroke Inch	Stroke M/M	Piston Displacement Cubic Inches	Compression Ratio	M.E.P. Pounds Per Square Inch	Carburetor Type	No.	Ignition Type	No.	Over All Dimensions Length	Width	Height	Athwartship Distance Between Brackets	Athwartship Distance Between Bolt Holes	Fore and Aft Distance Between Brackets	Max. Distance Between End Bolt Holes
[illegible]maine L-6					4¾	108	6½	165					2	Delco	2							
Curtiss OX2	36¾				4	102	5	127	502			Zenith		Berling	1	30	30	27		12⅞	9	
" OXX2	24	22½	23 2	10 6	4¼	108	5	127	568			Duplex			1	30	30	29		12⅞	9	
" OXX3					4¼	108	5	127	568					"	1							
" OX5					4	102	5	127	502		103				1							
" VX	66	64	45	12 2	5	127	7	178	1100	4.5 1	111		1		2	67⅜	35	34	14	16	6	
" VX3	94	64	14 7	12 2	5	127	7	178	1100	4.75 1	110		1	"	2							
" K-6					4½	114	6	152	573						2	63	22⅝	39¼	15¾			
" K-12					4½	114	6	152	1145	6 1	124				2							
Duesenberg A4			29 5	4 8	4¾	120	7	178	496							43⅞	15½	37⅞	13⅝	14¼	13⅝	
" H					6	152	7½	191	3390		118	Miller	4	Dixie	[illegible]	102[illegible]	31[illegible]	45¾		17¾		
Gnome Gen V														A.D.S.	1e							
					4 33	110	5 9	150	920			None		"	1e							
														"	1e							
Hall-Scott A7	46	37	28 9	4 5	5	127	7	178	550					Dixie	2	57	23⅝	30½	14	16	16¼	23¼
A7a					5½	133	7	178	577					"	2	57	23½	30½	14	16	16¼	23¼
A5	45	42 5	30 6	6 8	5	127	7	178	825					"	2	63⅜	25½	41¼	14	16	35¼	
A5a					5¼	133	7	178	865					Berling	2		25¾	45½	14	16	35¾	
L4					5	127	7	178	550	5.5 1		Miller	1	Delco, Batt. Special								
L6a					5	127	7	178	825	5.5 1			2	"	2	65	18¼	44	14	16	16¾	33¾
A8					5	127	7	178	1650													
Hispano-Suiza A or I	46 3	17	13 5	28 3	4 72	120	5 12	130	718	4.7 1	106 7		1	Dixie	2	51 33	33⅛	32 67				
" E.					4 72	120	5 12	130	718	5.3 1	124 0		1	Dixie 800	2	47 24	33½	33 34				
"					4 72	120	5 12	130	718	4.7 1	111 7		1	"	2	51 2	33½	33 34				
"					4 72	120	5 12	130	718	5.3 1	124 0		1	"	2							
" H					5 5	140	5 6	150	1122	5.3 1	131 0	Stromberg or Zenith	1 1		2							
" H					5 5	140	5 6	150	1122	5.3 1	124 0	Stromberg	1		2							
King Bugatti					4 33	110	6 3	160	1484	5 1				Dixie 800	4	61	26¼	33½		24¾		
King					5½	140	7.0	178	1995	5 1	110	Special			2							
Lawrance L-1-60					4¼	108	5¼	133	225			Miller										
Le Rhone					4 13	105	5 51	140	667	4.8 1	83 2	Block Tube Type		A.D.S.	1e							
" Alum Piston					4 41	112	6 09	170	917	4.82 1	87 5			"	1e							
Liberty A.	[illegible]	45		20	5	127	7	178	1649	5.5 1	115	Zenith Liberty	2	Delco Spec. Batt.		70 11/16	27	43½	15	17		39
" C					5	127	7	178	1649	5 1	112		2	"		70 11/16	27	43½	15	17		39
" "4"					5	127	7	178	549	5.5 1	120											
" "6"					5	127	7	178	825	5.5 1												
" "8"					5	127	7	178	1100	5.5 1	115	"										
Packard 1-A-744	[illegible]1				4¾	120	5¼	133	742					Delco			27½					
Sturtevant 5A					4	102	5½	140	552			Zenith	1	Dixie	2	50 5/16	34	34 5/16	11½	13¾	14 1/16	28⅛
" 5A-4½					4½	114	5½	140	700			Zenith	1 2			50 5/16	34	34 5/16	11½	13¾	14 1/16	28⅛
" 7					4½	114	5½	140	1050			Zenith	2	Dixie	2							
Thomas 88					4⅛	105	5½	140	586					Dixie	2						13 1/16	
Union					4¾	120	6½	165	728					Berling or Dixie	2	65⅛	17	42¾				
Wisconsin	50	42			5	127	6½	165	766							67 7/16	24	41 5/16	13¾	18½	14½	
	92		14 2	19 8	5	127	6½	165	1532				4			76 3/8	37½	37 5/16	15½	16½	14¾	

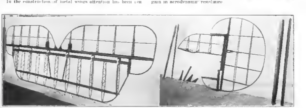
Empire Art Metal Construction in the Airplane

For same time past the Empire Art Metal Co. has been conducting persevering and successful experiments in the application of metal construction to the airplane. The accompanying illustrations and the following brief description will give airplane constructors an idea of the valuable work of this firm, to be followed by a full description at some later date. Almost the entire structure of the airplane is covered, and the show exhibit of the company comprises an all-steel wing and steel struts, and all-steel tail surfaces.



All-Steel Lower Wing Panel of a JN-4 Airplane

In the construction of metal wings attention has been concentrated on the wings of the JN-4 D type of biplane. The usual wooden type of wings has been replaced successfully by the steel product without any difficulties in adaptation, in the U-design of suitable fittings, etc. Comparative sand tests have been carried out at McCook Field on JN-4 D wooden wings, unheat-treated steel wings, and heat-treated wings, under exactly the same conditions. The results of these tests, given herewith, are the best criterion as to the merits of this construction.



Fins, Elevator and Rudder for a USA-C2 Airplane

Type of Wing	Weight of Complete JN4D Wing Truss.	Factor of Safety Under Sand Test.
Wood	398	7.2
Steel unheat treated	424	6.6
Steel heat treated	425	8.0

Considering the production possibilities of steel, its durability and resistance to fire, and the possibility of further refinement and lightening in construction, steel wings certainly seem promising.

Steel struts compare very favorably with wood on a basis of strength for a given weight of strut, but they also offer the advantage of having less aerodynamic resistance. Owing to the fact that the modulus of elasticity of steel is nearly twenty times as great as that of wood, a section of much smaller maximum thickness can be used with a corresponding gain in aerodynamic resistance.

A series of tests on Empire steel struts of an average length of some 60 in. and a thickness of 0.26 in., made of rolled steel sheet but welded along the front edge, gave results on which the following table is based:

Strut Type	Length In.	Thickness of Section In.	Weight per Ft. In Lb.	Weight Per Ft. Per ct.	Max Thickness. Per ct.	Maximum Load
Empire steel struts	60	1.06	55	100	100	1,680 (test average)
Spruce struts of same calculated strength	60	1.28	62	110	120	1,760 (calculated)
Spruce struts of same calculated weight	60	1.10	53	100	112	1,310 (calculated)
Spruce struts of same calculated size	60	1.06	43	56	100	840 (calculated)

For the same weight, a hollow steel strut is much stronger than a spruce strut, and has a smaller maximum diameter. For the same strength a steel strut has a smaller maximum diameter and weight than a spruce strut. Besides these advantages, the steel strut is a true production proposition with less possibilities of rejections and defects.

In control surfaces the Empire Art Metal Co. have produced an absolutely reliable product, and which is adaptable to any type of airplane or seaplane. On sand test these control surfaces have proved free from local weaknesses in design, have a light weight per square foot, and are of ample strength.

A set of control surfaces built for the USA C2 (as indicated in Figs. 2 and 3), made of unheat-treated steel of a tensile strength of less than 60,000 lb./sq in. developed the following strength:

	Surface Sq Ft.	Weight. Lb	Weight Sq Ft Lb	Ultimate Load. Lb. Sq Ft.
Elevator	23½	21	794	62
Stabilizer	34	32¾	960	*
Rudder	12½	10½	86	44.8
Fin	7½	11	1.52	44.8

* Undamaged carrying elevator load as above and 20.5 lb./sq. ft. on stabilizer.

This compares more than favorably with any wooden surfaces available.

The Liberty Starter for Aircraft Engines

A number of features of unusual interest from the engineering standpoint are to be found in the new Liberty starter for aircraft engines, which is the product of the Liberty Starter Corporation. The Liberty starter was submitted to the Bureau of Steam Engineering of the Navy Department some months ago, where it passed most satisfactorily all preliminary tests. As a result, the Navy placed an order for a number of these starters which have since been delivered.

Among its advantages are the following:

(1) A single compact unit which encloses both hand starting gear reduction and the electric starter in one unit.

(2) Hand starting attachment for cranking engine, if trouble should develop owing to run down batteries, etc.

(3) A unit aligning directly with the crankshaft of the engine throws no strain upon the engine bearings and the starting unit becoming, as it were, a part of the crankcase.

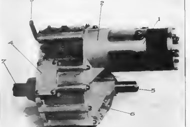


Fig 1 Liberty Starter Assembled

(4) The mounting of the starting unit on the end of the cranking shaft opposite to the propeller end—thus doing away with head resistance, freakish design radiators, etc.

(5) Oil and waterproof features as the entire starting unit is enclosed so it is protected from the elements.

(6) The starter with the hand cranking attachment weighs about one-third less than any separate hand and electric starter not combined.

Thus far these starters have met all demands made upon them, and it is expected that as soon as the Liberty Starter Corporation completes its factory, which is now building at Poughkeepsie, N. Y., to continue the manufacture of starters for the Navy and Army, as well as for export. It has been demonstrated that a starter is absolutely essential to the safe and efficient operation of airplanes, but that a much more compact and efficient device is necessary than for the automobile, because the airplane engine is not fitted with a flywheel; therefore, the starter must be attached direct to the crankshaft. This has been accomplished in the Liberty starter by the use of reduction gears, which are so arranged that at least one-quarter of the diameter of the gears is in mesh at all times.

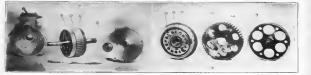
The Liberty is the only starter that combines electric and hand cranking; it develops nearly 2,000 ft. lb. on the crankshaft.

In the attachment of the starter to a large engine, no change, whatever, is necessary, it being fitted direct to the crankcase, opposite the propeller end, the splines on the engine shaft fitting those in the hub of the gear attached to the engine crankshaft. The starter is entirely self-contained, and after it has performed its function as a starting device, it acts as a small flywheel, avoiding the necessity of the engaging or disengaging of any gears, clutches or driving mechanism.

Provision is made on the starter case for the attachment of synchronizing gears, generator or starting magnets, where engines are fitted only with magneto ignition. By the attachment of the generator, current can be supplied for recharging the starting battery, as well as for lights and wireless service. In short, it is a complete electric generating and starting system, at a weight of little more than the average hand geared starter.

Fig. 1 shows the starter completely assembled and ready for attachment to a Liberty aircraft engine. Part 1 is the electric motor, which is used for electrical cranking; part 5 is the place where the hand-crank can be attached to crank the engine through a portion of the reduction, thus enabling the aviator, in case of failure to his electrical equipment, to crank the engine by means of a small hand-crank without touching the propeller. Part 2 is the casing which encloses the gear reduction, this is made oil and water tight, the gears revolving in a bath of oil at all times. Part 3 is a switch handle which connects to a cord, etc., in the

reach of the [illegible] starting motor mains. Part 1 is a plate which has to be installed for mounting accessories to be driven by the [illegible] engine electric generator, machine gun synchronizer, etc. Part 7 connects directly with the crankshaft, being keyed to it by gear 15 with [illegible] gear 10. But while in cranking, it [illegible] locked by reason of the pawls in conjunction with the [illegible] switch the rotating of the eccentric gear causes internal gear 17 to revolve, thus cranking the engine. When the engine rotates under its own



Figs 2 and 3. Parts of the Liberty Starter

means of external splines. Pads are provided on part 6 for bevel gear mounting if the hand-crank is to be mounted at right angles to the crankshaft.

Fig. 2 shows a partially dissembled view of the interior, showing the motor pinion which meshes with gear 9. Part 10 is a one-way racket gear, which is held when starting by pawls (not shown) when the starting switch is operated. Part 11 is a gear which corresponds with opening in the crankcase for driving before mentioned accessories. The interior gear reduction operates through an eccentric 12, which is fastened to the hand-cranking shaft and to which gear 9 is mounted. This eccentric engages an inner race of a bearing mounted in an external gear 15. This gear being revolvably and eccentrically mounted in an internal gear 17, there being only a few teeth difference between the two gears. A universal plate 13 engages with studs 15 upon the external gear and also interlocks upon studs 14 in racket gear 10, this plate allowing a universal movement of the external power the racket teeth of gear 10 over-rachet, and when the aviator releases the starting switch the pawls are lifted out of engagement and the unit revolves as a small fly-wheel. As it does not drive gear 9, the electric motor need not be disengaged. The electric motor connects gears at a ratio of 12 to 1 to the eccentric, the eccentric and internal and external combination being worked out at a ratio of 21 to 1, so if hand power alone is employed with crank the ratio will be 21 to 1. The electric power cranking at 12 x 21 or 250 to 1.

In the gear reduction, ball bearings are used exclusively and run in a continuous bath of oil.

The universal plate in the gear reduction is so designed that the entire revolving mass is balanced. The starting motor torque is approximately 12 ft. lb. and has sufficient speed, owing to the reduction of 250 to 1, to crank the engine between 25 and 50 r. p. m., depending on the condition of the engine.

Stewart-Hartshorn Streamline Wire

The following interesting data are supplied by the Stewart Hartshorn Co. on their Streamline Wire.

The method employed by this firm is known as the cold reverse rolling method, which is briefly described as follows: Coils of rod as received from the steel mill are cold drawn to the desired finished round. These coils of wire are then straightened and cut to the required length, and then rolled in a specially designed rolling mill. Wires are placed in the machine and first passed in one direction and then in the reverse direction, each pass reducing the round nearer to the streamline shape. This operation requires a considerable amount of skill, for when a wire is brought to the specified width and thickness, the given length between the shoulders must be produced. By this method wires of any length and cross-section may be made, and are always indicated by the threaded portion. The following table, as revised by the Army and Navy, shows the various sizes and properties of streamline wires.

No.	Threads	Ult. Threaded Portion Lbs	Width	Thickness	Area Streamline Sq. In.	Ult. Streamline Portion Lbs
1	6-40	1350	.132	.048	.0071	1000
2	10-32	2700	.230	.064	.0128	1900
3	1/4-28	5000	.348	.087	.0234	3400
4	5/16-24	8050	.440	.110	.0376	5700
5	3/8-24	12400	.548	.130	.0563	8500
6	7/16-20	16700	.630	.159	.0781	11500
7	1/2-20	22800	.732	.182	.1026	15500
8	9/16-18	28700	.830	.209	.1354	20200
9	5/8-18	33600	.924	.231	.1650	24700

Material used is of the following analysis:

Car	40 —	50
Mang	50	80
Phos Max	.045	
Sulp Max	.050	

A special method of heat treating was employed by the Hartshorn Co., which brought about physical properties well above those specified by the United States Government, which called for an ultimate strength of 150,000 lb per sq in and three reversible bends through 180 deg. The Hartshorn wire averaged 170,000 lb ultimate per sq in and fifteen bends through 180 deg without fracture. These bends were made in a vise, the gripping edges of which were rounded to a radius equal to three times the thickness of the metal tested.

To test out the flight properties of streamline wire the Airplane Engineering Division, Air Service, equipped a DH 4A plane with double flying wires and single landing, drift, interplane and tail unit brace wires made by the Hartshorn Co. The performance was as follows:

	With cable Speed m p h	r p m	With streamline wire Speed m p h.	r p.m.
5000	122.0	1700	128.0	1680
6500	121.0	1670	126.5	1670
10000	118.5	1620	124.0	1620
13000	115.0	1570	122.0	1580
15000	118.5	1540	110.0	1540

The pilot and observer reported a noticeable increase in flying and climbing speed; the initial climb to 5000 ft was made in 3 min 40 sec and the highest altitude reached was 16,000 ft. The average increase in speed was 5.5 m.p.h.

The Ansaldo Single and Two Seater Airplanes

The SVA long range reconnaissance and day bomber has been designed by Cols. Savoia and Verduzio of the Italian Army for the SPA motor with the aim of including all the most scientific development of aviation and attaining a maximum of efficiency.

Three-Quarter Rear View of the Ansaldo I Fighter

The special features of the SVA are

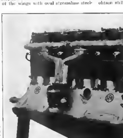
a) the minimum head resistance of the whole machine

b) the special wing section

c) the rigid trussing of the wings with oval streamline steel tubing, which totally dispenses with the use of cables and the need of frequent adjustments

d) the form and construction of the body, gradually passing from the rectangular to a triangular section which gives very efficient aerodynamical results. The body is built up of wooden longerons and ribs, and plywood panels, being extremely rigid, strong and light.

The specifications of the SVA are: Engine, SPA, Ansaldo 6-cyl., 220 hp.; Speed, 140 m.p.h.; Climb, 20,000 ft in 30 min.; Useful load 1000 lb.; Normal flight endurance, 6 hr., or 840 miles (with 250 lb. of bombs or mail); Armament, 2 fixed machine guns firing through propeller.



The Ansaldo-SPA 210-hp. Engine

The SVA is also made in two seater and seaplane types. This type has been largely used at the Italian front.

A squadron of seven SVAs. commanded by Major Gabriel d'Annunzio, flew from the Italian front to Vienna bombarding the city with propaganda papers and returned covering more than 700 miles with a total duration of the flight of 6 hr. 40 min.

Other remarkable records of the SVA are: Torino-Udine-Torino, 700 miles in 5 hr.; Malpensa-Foggia-Bologna, 900 miles in 6 hr. 50 min., beside a great number of war reconnaissance and bombing flights over Austrian and German soil.

In America a SVA piloted by Sig Gino made brilliant official tests and flew from Langley Field, Va., to Washington in 1 hour and from Washington to Belmont Park, Long Island, in 1 hour 30 minutes.

The "Balilla," officially called Ansaldo I, is a single seater fighter, and has the same engine as the SVA; it is built on the same principles, but in smaller dimensions in order to obtain still greater maneuvering ability, climb and speed.

On account of the smaller wing spread, the wing truss is reduced to a system of two steel struts for each wing with the usual cross cables. It has also a rigid control of ailerons and a special release system allowing to drop instantly the gasoline tank in case of fire.

The specifications of the Balilla are: Engine, SPA-Ansaldo 6 cyl. 220 hp.; Speed, 145 m.p.h.; climb, 20,000 ft. in 25 min.; Useful load, 550 lb.; Normal flight endurance, 3 hr.; Armament, 2 fixed machine guns firing through propeller.

The Balilla has been lately used on the Italian front and has many enemy planes at its credit.

The SPA-Ansaldo engine, used in the SVA and Balilla plane, is a vertical 6-cyl. water-cooled engine of following specifications: Power, 210 hp. at 1600 r.p.m., 225 hp. at 1700 r.p.m.; Weight (including water), 550 lb.; Drive, direct from crankshaft; Bore, 135 mm. (5 5/16 in.); Stroke, 170 mm. (6 11/16 in.); Gas consumption, 17.5 gal. p. hr. at full power, 16 gal. p. hr. at 1500 r.p.m.; Oil Consumption, 6 lb. p. hr.

The aeronautical branch of the Ansaldo Co. of Genoa, manufacturing airplanes and engines, attained during the war very ample expansion and production, including several factories and testing fields.

Development of the American Airship Industry

By Ladislas d'Orey

When the United States entered the Great War there was no American airship industry in being However, in the spring of 1917 the Bureau of Construction and Repair of the Navy Department issued specifications and asked for bids on sixteen small airships of the so-called Blimp type, which was a British war development Orders were subsequently awarded to several firms who have had previous—though little—experience in airship construction, and eventually, with the experience gained in practical experiments, American manufacturers were able to produce a satisfactory type of airship for coastal service

The Blimp type of airship is essentially a non rigid to which is slung the body of a tractor or pusher airplane, complete with its engine and aircrew While these craft have given a satisfactory service within the limits of their possibilities, the Navy Department decided last year that a much larger and more powerful type was desirable for the purpose of efficiently carrying out coast patrol work. Consequently specifications and bids were issued for a number of twin-engine airships having about twice the capacity of the Blimps, and the orders, awarded since are now being filled by American manufacturers, as appears from the appended table

It is noteworthy, that while the Navy specifications for Blimps, prepared by Naval Constructor J C Hunsaker, were based on the best available foreign designs, American airship manufacturers soon succeeded in greatly improving these plans, developing thereby a distinctly national product. The rigging of the car to the envelope came in for particular attention in the course of this work, with the result that the heavy belly band, a well-nigh universal practice derived from the Parseval airships, was advantageously replaced by the direct or patch type of rigging The Goodyear Tire and Rubber Co did pioneer work in this respect, for their finger patch rigging effectually disposed of the theory that the direct rigging developed undue local strains upon the balloon fabric.

Latterly the B F Goodrich Co, who had built their Blimps to belly-band rigging, further emphasized the fallacy of this contention by developing the so-called horse shoe patch, which will be exclusively used on their twin-engine naval airships.

Since the successful discovery, by American chemists, of a means whereby helium a non inflammable gas, can be produced in quantities and at a comparatively low cost—10 cents per cu ft—the Navy is, however, no longer the sole user of airships, for the Army, fully realizing the great value of lighter than air craft for certain purposes, has recently started upon a program of its own The Balloon and Airship Division of the Air Service, which is in charge of Col J Prentice, U S A has lately placed orders for half a dozen non rigid airships of about 75,000 cu ft. capacity, which it is intended to use for fire-control work in connection with coast fortifications as well as for liaison service.

Nor are the commercial possibilities of large airships—which have been repeatedly pointed out in these columns—overlooked by American manufacturers. At the Aeronautical Exposition, in New York, the Goodyear Tire and Rubber Co exhibited a scale model of the passenger car of a semi rigid transcontinental airship which is to be 400 ft long, 65 ft in diameter, and have a capacity of 750,000 cu ft. The power plant is to consist of two 450 hp engines, and the endurance of the airship is estimated to be 2,000 miles at 60 m.p.h Accommodations are to be provided for twenty-four passengers.

At the same show the Connecticut Aircraft Corp exhibited a scale model of a 300,000 cu. ft passenger airship of the non-rigid type, with belly band rigging, fitted with two engines totaling 400 hp, and providing accommodation for twenty passengers The full speed of this airship is to be 60 m.p.h

Resuming, it may be said that American manufacturers of lighter-than-air craft are fully aware of the great possibilities the recent developments in airship construction offer for long distance passenger services, and interesting developments in this field may be looked forward to in the near future

Characteristics of American Naval Airships

Built or Building	Year	Manufacturer	Mf'r's Type	Navy Class	Capacity (cu ft)	Length (ft)	Width (ft)	Height (ft)	Total Horsepower	No and Make of Engines	No of Aircrews	Crew	Full Speed (m p h)	Full Speed Endurance (hr)	Rate of Climb (ft per min)	Static Ceiling (ft)
Twin-Engine Coast Patrol Airships																
5	1919	Goodyear	UA	D	180,000	198	43	54	250	2 Union	2	4	60	12	1,000	8,000
3	1919	Goodrich	C	D	180,000	198	43	54	250	2 Union	2	4	60	12	1,000	8,000
8	1918-19	Goodyear	U	C	170,000	190	43	54	300	2 Hispano-Suiza I	2	4	60	10	1,000	8,000
8	1918-19	Goodrich	B	C	170,000	190	43	54	300	2 Hispano-Suiza I	2	4	60	10	1,000	8,000
Single-Engine Submarine Scouts																
1	1918	Goodyear	FC	F	95,000	162	33 6	45	125	1 Union	1	3	55	12	700	7,000
1	1918	Goodyear	FB	E	95,000	163	31 5	45	150	1 Thomas 88'	1	3	52	12	700	7,000
12	1918	Goodyear	FA	B	84,000	163	31 5	45	100	1 Curtiss OXX 3	1	2	49	10	700	7,000
12	1917	Goodyear	F	B	77,000	160	31 5	45	100	1 Curtiss OXX 2	1	2	45	10	700	7,000
7	1917-18	Goodrich	A	B	80,000	167	33	50	100	1 Curtiss OXX 2	1	2	35-43	10	700	7,000
2	1917	Connecticut Aircraft Co	B	B	77,000	165	31 5	45	100	1 Hall-Scott A-7-a	1	2	44 47	10	700	7,000

The Goodrich Naval Airship A-247

The Goodrich naval airship A-247, which is illustrated herewith as she appeared in the 69th Regiment Armory during the Aeronautical Exposition, was built in July and August, 1917, at the Goodrich factory, in Akron, and was accepted by the Navy after a series of tests conducted under cover of darkness over Lake Michigan, on Sept 11, 1917

Goodrich Naval Airship at the Aeronautical Exposition

Although the average life of an airship of this type is estimated at from six to nine months, the A-247 remained in active service till Feb 15, 1919, when the Navy authorized her builders to give the public a close-up view of the type of aircraft which played such a notable role in the convoying of American troopships through the submarine infested waters of the Atlantic.

The A-247 has a capacity of about 80,000 cu ft, and is fitted with a Curtiss OXX-2 engine, developing 100 hp, which drives the ship at a speed of 35 m p h The cost of its inflation with hydrogen is about $1,200 Airships of this type, which were built after the specifications of the Bureau of Construction and Repair of the Navy Department under the supervision of Henri Julliot, the well known French airship designer, have extensively been used in coast patrol work both here and abroad.

The B. F. Goodrich Co during the war has built seven airships of this type for the United States Navy, beside furnishing 362 kite and observation, ten supply and two target balloons to both the Army and the Navy

Since the armistice was signed, this firm was awarded by the Navy Department an order for nine twin-engine coast patrol

airships, the characteristics of which are given in the table of American naval airships, printed elsewhere in this issue. Beside their much greater size and power, these airships are notable for the rigging which secures the car to the envelope. This is of the so-called horseshoe patch type, and distributes the strains radially over a great area of the envelope. The shape of this patch may be seen in the accompanying illustration, on the upper part of the envelope of the A-247, where it is used for attaching the cables by means of which the vessel was suspended from the roof of the 69th Regiment Armory.

The Goodrich exhibit at the Aeronautical Exposition included a very interesting type of parachute which is attached to the basket of a balloon and may in case of accident be released with the latter from the gas bag. This arrangement dispenses the balloon observer from jumping overboard, as has hitherto been the custom, in case the balloon is set on fire, and constitutes thus a notable innovation. Another Goodrich invention of great value is the Gammeter valve, which insures uniform pressure in an inflated balloon regardless of the altitude or the temperature.

Inter-Communication on Board Airplanes

One of the most difficult problems arising with the rapidly increasing development of aviation has been that of providing a satisfactory means for voice communication between the occupants of airplanes. While the telephone methods of inter communication have been applied to the solution of this problem, they have been successful in excluding outside noises and in transmitting vocal chord vibrations only to a degree; in fact the articulation of words is generally poor with these systems.

With a view to solving this problem, B. F. Miessner, a well-known radio engineer, has developed an inter-communication device which has proven entirely satisfactory both from the viewpoint of effectively transmitting articulate speech through powerful noise interferences with a clearness far in advance of present telephonic development, and which is simple in construction and practical in operation, of light weight, comfortable to wear, and does not employ delicate mechanisms, batteries, nor electrical connections.

The Miessner Airfone

This device Mr. Miessner has named the Airfone. This name was chosen, first, because the airfone is purely an air or pneumatic phonetic device, and, second, because its chief use is for aircraft service.

The Airfone is a form of speaking tube designed especially for inter-communication between pilot and observer, instructor and student, or any airplane occupants, during full power flight. It consists essentially of a flexible speaking tube provided with a mouth piece and a neck band, and of a helmet to which two earpieces are attached, suitable connections between the speaking tube and the earpieces being provided. For two-way conversation, two such head gears and tubes are used.

The two chief considerations governing the design of a speaking tube for airplane service have been found to be:

First, effectively to prevent the airplane noises from reaching the ears directly, through or around the earpieces, and second to obtain the highest ratio of intensity of voice sounds to airplane noises reaching the ears through the speaking tube; in addition it is necessary that the acoustic characteristics of the tube be such as to permit of good articulation. Of these two governing conditions, the first is met by the earpiece design, which permits of leading the voice vibrations directly to the ears, and of barring, to a large extent, entrance of interfering noises. These earpieces are mounted in the helmet and consist of pneumatic cushions or rings which surround the external ear and maintain an airtight contact with the head, with but small pressure. They are very efficient as well as comfortable. Three head piece designs consist in:

1. The use of a hard helmet.
2. The use of a soft helmet.
3. The use of any helmet, the earpieces being attached to an elastic head band, and worn underneath any helmet.

The second governing condition relating to the design of the voice duct requiring the maximum intensity ratio of voice sound to airplane noises is a matter which demands the closest attention in securing the best results.

Tube Length—Except for very short tube lengths there is a definite length which will give best results for a given airplane. Inasmuch as the engine exhaust noises are the most powerful that have to be contended with and as they are periodic with a fairly uniform frequency, they can be reckoned with on this basis. Tube lengths equal to 1-4, 3-4, 5-4, etc., of the wave length of these engine exhaust sounds must be avoided in order to prevent their amplification by resonance.

Tube Diameter—A consideration of the limiting values indicates that an optimum tube diameter exists. An infinitely small tube, it is evident, would offer an infinitely high resistance to the propagation of the voice vibrations; on the other hand, an infinitely large tube would duplicate the conditions applying in talking directly through the air, which is impossible. In general, that tube length is to be preferred which will transmit the airplane noises with no greater intensity than those reaching the ears around the ear caps.

Tube Walls—The material comprising the walls of the tube, aside from the requirements as to flexibility, light weight, durability, etc., must prevent both the escape of voice sounds and the entrance of airplane noises, and in addition the inside surface should be such as to break up any tendency of the enclosed air column to oscillate freely. This is desirable, firstly, so that the air column be an aperiodic vibratory body, which is necessary, in order to prevent voice distortion; and secondly, so that it will form a very poor resonator to any periodic airplane noises which otherwise might be amplified by resonance.

All of these more important factors, as well as others of a purely practical nature, have determined the design of the Airfone, and the highly satisfactory results obtained wherever it has been used testify eloquently to the wisdom of the course, as distinguished from a design based only upon cut-and-try guesswork.

As distinguished from the telephone method of communication, the speaking tube has the additional great inherent advantage of requiring no vibratory diaphragms in the sound path from the speaker to the listener. These are, of course, a necessary evil in the electrical transmission of speech, for they not only distort many of the transmitted speech sounds out of all true similarity to the actuating vibrations, but they also hinder or prevent entirely the transmission of many of the complex vibrations comprising articulate speech. The result is that only the mere skeleton of a spoken word is transmitted, and this explains the fact that, when unassisted by the context of the telephone speech, such a very low percentage of words can be understood even with the best telephone equipment and without noise interference.

The Airfone has indeed proven an admirable solution of this heretofore perplexing problem of pilot-observer communication and it fills a strongly felt need in the whole field of aviation.

For student training it is of inestimable value, since by its use a student can be trained to fly in a remarkably short space of time. Various aviation instructors have shown that in many instances the necessary time of instruction could be cut in half, so that the cost of such instruction is greatly reduced. Absolute novices have piloted airplanes on their first flights when instructed by experts through the Airfone.

For such aircraft as are equipped with radio reception apparatus, a combination radio and airfone helmet has been devised by Mr. Miessner, wherein the pilot's voice sounds, as well as the radio signals or speech, reach the ears through a common or combined ear-piece, so that these communications may be received seperately or simultaneously, as desired by the radio operator.

Book Reviews

Airplane Propellers (Jacuzzi Brothers, 35 pp. $1.50.)

This is a very complete catalogue of propellers made by Jacuzzi Brothers for a number of well-known airplanes and engines. The propeller diameters, pitch, engine horsepower and r.p.m. are given. A table of propeller hub dimensions is a useful addition to the booklet. The manufacturers are perhaps a little too positive in their figures as to efficiency, etc., since the performance of a propeller is ultimately connected with that of the plane they use, but the book constitutes, nevertheless, a very valuable reference work.

Automotive Starting, Lighting and Ignition. By R. C. Fryer. (John Wiley & Son, 210 pp., with diagrams. $1.25.)

This book was written in conjunction with Mr. Fryer's work as instructor in the School for Auto Mechanics, War Education Department, University of Cincinnati. It is mainly concerned with the electrical systems of well known automobiles, but is interesting, nevertheless, from an aero engine point of view. It reviews the fundamental principles of electricity and magnetism; a very comprehensive classification of all well-known ignition systems follows. Bench tests, the care of commutators on generators and starting motors, the care of storage batteries, etc., are treated in a very practical fashion. The firing order and timing of all well-known cars are set down systematically. The diagrams at the end of the book are very clear.

Enemy Aircraft Engines. (Iliffe & Sons, Ltd., 2 Tudor Street, London. 10 6 net. 67 pages, illustrated profusely.)

This is an exceedingly interesting set of reprints from the London Automobile Journal, beautifully printed and profusely illustrated. Detailed descriptions are given of the following German engines: 200 h.p. Maybach, 160 h.p. Benz, 200 h.p. Mercedes, 160 h.p. Mercedes and 230 h.p. Benz. Descriptions, including assembly and detail line drawings, photographs, main dimensions, performance curves, etc. A particularly interesting description is given of the German engine trials with layout of the testing laboratories.

Tabular results showing weight per hp. in relation to consumption are shown for a number of other engines.

These articles aroused the greatest interest at the time of their first publication in the Automobile Journal, and their collection is very timely and useful.

First Passenger Airplane Line

The first trans-continental passenger airplane line will begin operation sometime next August, according to a statement issued during the Aeronautical Exposition in New York by Wesley L. Hill, president of the Apache Aerial Transportation Co. Orders have been placed with the Glenn L. Martin Co. for four of their twin-engine biplanes.

These machines will be similar to the well-known Martin bomber, except that a limousine body will be fitted for the passengers.

Some time early in August, Mr. Hill says he will start the fleet of four planes from New York City. Each will carry ten passengers, in addition to the pilot and mechanician, and their destination will be Los Angeles. This will be the inauguration of the first trans-continental aerial passenger service and the trip will take about four days. Stops will be made in Cleveland, Chicago, Kansas City and other cities over the Southern route where army landing fields can be found to accommodate the planes.

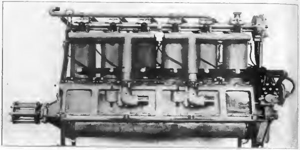
Lieut. W. A. Hill at the Wheel of a Martin Twin-Engine Biplane, Which Will Be Converted Into a Ten-Passenger Machine for Trans-Continental Traffic

On arriving on the western coast, Mr. Hill intends to establish a coastwise, regular schedule aerial passenger service. Just as soon as he has convinced the public of the dependability and safety of air travel, according to his statement, he will open another scheduled aerial passenger route from Los Angeles to El Paso, Texas, a distance of 1,200 miles, which it is expected will be done by air in nine hours against twenty-two hours by train.

The company will establish the Pacific Coast leg of the first transcontinental air route, operating from El Paso to Los Angeles to San Diego and San Francisco. As a preliminary operation to prove the success of the undertaking and organization, regular service will be established between Globe and Phoenix, Ariz., and San Diego, Cal.; also a kite shaped trip taking in Los Angeles, Pasadena, Pomona, Riverside and other inland coast towns. By the summer of 1920 and probably before, another service will be established between Port Los Angeles and Catalina Island. This of course, will be conducted with seaplanes.

The 125 Hp. Union Aircraft Engine

The 125 hp Union aircraft engine is the product of the Union Gas Engine Co, of Oakland, Cal It is of the vertical 6-cyl water-cooled type, with valves in the head, and develops its rated horsepower at 1,400 r p m The weight of the engine complete with two carburetors, two magnetos, pumps and



Intake Side of the 125 Hp. Union Engine

water piping, is 485 lb., which gives a weight of 3 88 lb per horsepower During a 48-hours endurance test, data on which are given herewith in tabulated form, this engine consumed an average of 0 558 lb of gasoline and 0 0124 lb of oil per b.hp hr

This low fuel and oil consumption as well as the great simplicity of design and all round sturdiness of the Union engine make of it a particularly desirable power plant for airships, where the question of massive weight is one of minor importance provided it insures reliability and dispenses with adjustments for long runs at a stretch That this engine well responds to these requirements may be seen from the Table of Characteristics of American Airships, printed elsewhere in this issue, from which it appears that the Navy specifications for the latest twin-engine coast patrol airships call for the fitting of Union engines. As the full speed, that is, the minimum endurance of these airships is 12 hr, and their operations often carry them far out to sea, the need for a power plant of the greatest reliability is obvious

The principal features of the Union aircraft engine are the following

Cylinders—The cylinders are of steel, with semi-steel head for valves and spark plugs, and the base flange integral with walls of cylinder In test, these cylinders when held by base flange only, withstood a hydraulic test of over 1200 lb per sq in, or a total pressure on the head and base flange of over ten tons.

The cylinder water-jackets are of copper, with brazed joints. Upward thrust of cylinders is taken by chrome nickel studs extending from main journal caps to cylinder flanges.

Valves—The valves are of E W P alloy The stem guide is long, and water-cooled for its entire length Valve springs are double, concentric, and of the helical type, right and left-hand.

Rocker Arms—The rocker arms are machined from solid chrome-nickel steel forgings, and heat-treated Bearings are $\frac{3}{4}$ in diameter and $2\frac{1}{2}$ in long Shape of arms is such that oil leakage is prevented without the use of packing Excessive wear of valve stem end, caused by point contact of adjusting screw, is eliminated by having line contact in place of point, length of contact between rocker end and valve stem being $\frac{3}{8}$ in Valve clearance is obtained by use of small cap with thin discs on end of stem Cap is held by cotter so that adjustment is positive

Camshaft Housing—The camshaft housing is split horizontally along the center line of the camshaft, permitting easy removal of shaft To prevent flooding of camshaft housing when climbing, a drain from each end of housing leads down to main crankcase sump

Camshaft Gears—All valve gears are of Midvale chrome nickel steel, heat-treated, and operate in oil bath

Pistons—The pistons are of Lynite aluminum alloy The piston length is 6 in the piston pin bearing is $1\frac{1}{4}$ in x $2\frac{3}{4}$ in

Connecting Rods—The connecting rods are I-beam section, of Midvale chrome nickel steel, heat treated

Crankshaft—Crankshaft journals are $2\frac{1}{2}$ in diameter by $2\frac{1}{2}$ in long, crank pins are $2\frac{1}{2}$ in diameter by 3 in long In addition to the seven main bearings, there is a bearing just outside of the thrust Shaft is made of Midvale chrome nickel steel, heat treated

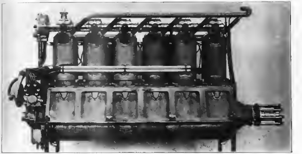
Thrust Bearing—The airscrew thrust is taken by a two-way, self aligning SKF bearing

Crankcase—The crankcase is of aluminum alloy, and in addition to thorough cross webbing, the side walls are of hollow box section The stiffness of this construction is so great that the entire airscrew torque can be taken through the length of the case without any signs of twisting or vibration, the case during this test being held from rotating at the end opposite to the airscrew end only

Lubrication—Oil is taken from the crankcase by a gear pump, delivered to a combined oil tank and cooler (located where convenient), from which it flows back to a second gear pump which sends it under a pressure of 40 to 90 lb to the crankshaft journals, through the shaft to the lower rod bearings and up into the piston pin The holes in the piston for the piston pin being sealed, the oil must pass between the outer surface of the pin and its bearing, whence it is carried to the

cylinder walls The camshaft, camshaft bearings, cams, rocker arms and valve gears are lubricated by oil by-passed from the oil pressure regulator This insured force-feed lubrication to all moving parts, even with no oil in the crankcase

Ignition—Current is furnished by two entirely independent magnetos of either Berling or Dixie make Each cylinder is



Exhaust Side of the 125 Hp Union Engine

fitted with two plugs, each plug being in close contact with a water-cooled wall for its entire circumference

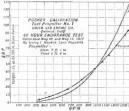
Magneto Drive—The magnetos are driven through combined driving gear and floating coupling in such a way that there is absolutely no end or radial thrust transmitted to the magneto bearings or armature shaft Removing four magneto holding-down screws allows the magneto to be readily withdrawn

Pump Drive—The centrifugal water pump is driven in a manner identical to that used for the magnetos, the driving gears and couplings being interchangeable The pump may be removed by withdrawing its two holding-down bolts.

Intake Manifold—The intake manifold is of copper, all joints and flanges being brazed. Flanges are of steel, held to cylinder ports by four bolts and nuts each The vertical section above carburetors is water jacketed

Crankcase Breathers — A small breather is located opposite each crank brass in such a way that cold air entering case strikes each crank brass, thus having a decided cooling effect Circulating through these breathers is maintained by a small part of the carburetor air being drawn through the crank case

Airscrew Flange—The airscrew flange may be drawn off at taper by means of special threaded collar between flange and thrust bearing



Performance Chart

Valve Timing—The valves may be quickly timed by means of indicating marks located on flange between thrust bearing and propeller

Bolts and Nuts.—S. A. E Standard bolt and nut dimensions are used throughout excepting where extra long threads are necessary as on bearing cap and crank brass nuts. Castellated nuts and cotters are used in place of lock washers. Bolts not so locked are drilled in the head and lashed by means of wire.

Wiring—High tension tested cables from magnetos to plugs are run in two separate metal conduits, thus preventing trouble from induced currents

Magneto Advance—Magneto breaker boxes are interconnected in such a way that a single rod from the cockpit advances and retards both magnetos simultaneously Adjustment is provided to permit synchronous timing of two magnetos.

Carburetor Safety Device—That part of air not taken from crankcase comes from one of the outer compartments of crankcase double wall Drains are provided to prevent accumulation of fuel

The results of a 48 hr endurance test conducted on May 10 18, 1917, under the supervision of Army and Navy inspectors in conformity with Army Specifications No 1002 are shown in the chart and table printed herewith

At the conclusion of this endurance test no appreciable wear was noted in the engine, as to adjustments these consisted, according to the official report, in cleaning spark plugs, adjusting gaps to 0 018 in, and cleaning the distributor raceway of carbon deposit These adjustments were made between runs, each run being a non-stop run.

The results of this test bring the fundamental features of the Union aircraft engine well to the fore

TABLE OF 48-HOUR ENDURANCE TEST

Propeller Pusher No 1—Pitch 6'-4", Diam. 8'-1"

DATE. May		11	13	14	15	16	17	18	Average
RUN NUMBER.	1	2	3	4	5	6	7	8	
DURATION HOURS.	8	7	5	6	8	8	6	6	
PRESSURES Barometer—in Hg. Cir Water—lb sq in. Lub Oil. lb. sq. in	 30.30 74	 30.10 66	 30.26 66	 30.20 7.5 100	 30.23 7.5 96	 30.22 7 94	 30.18 8.25 92.5	 30.18 8.25 87	 30.21 7 90
TEMPERATURES Deg. F Outside Air Cir Water Inlet Cir Water Outlet Lub Oil Final	 62 140 155.8 100	 62 160 162 98	 59 166 164 98	 56 140 166 96.6	 58 142 158 96	 57 142 158 94	 58 144 161 92.5	 59 143 158 95	 58 140 157 9..
GASOLINE Standard oil of 58° Baume Gallons hour Lb. hp hour	 10.5 0.508	 10.0 0.537	 11.3 0.590	 10.6 0.540	 10.75 0.543	 10.66 0.537	 10.7 0.580	 10.66 0.500	 10.7 0.5..
OIL Wolfhoods of 30° B Gallons hour Lb hp hour	 0.25 0.015	 0.68 0.038	 0.40 0.024	 0.21 0.0125	 0.25 0.0148	 0.20 0.0123	 0.30 0.02	 0.33 0.023	 0.27 0.0124
POWER. R. p m Torque Lb ft B. hp	 1348 464 123.5	 1361 473 122.5	 1341 468 118	 1347 478 122.6	 1357 483 123	 1334 468 118.7	 1265 452 114	 1337 466 118	 1341 472 120
OVERALL THERMAL EFF'Y	0.049	0.220	0.213	0.228	0.227	0.217	0.210	0.220	0.222

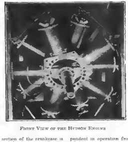
The Hudson 120 Hp. Airplane Engine

The Hudson 120 hp. airplane engine is of the stationary air-cooled type, with ten cylinders of 4 5/16 in. bore and 4 3/4 in. stroke arranged radially around the crankcase. It was designed by John W. Hudson, of San Francisco, Cal., after a series of experiments with radial engines of the five and ten cylinder type, which extended over a period of ten years.

The object sought in the construction of this engine was to have a power plant embodying light weight, great strength, and fuel economy. The characteristics and performance of the Hudson engine show that these requirements were well attained, for the engine develops 140 h.p. at 1,500 r.p.m.; weighs, complete, 320 lbs., and consumes 7 gals. of gasoline and 1 gal. of oil per hour at maximum speed. This consumption was attained during a 100 hr. run, at the end of which only a wrist pin and a bushing had to be replaced.

The crankcase is made of three parts. The front section is a forging upon which is welded a pressed steel cone which affords support to the magnetos. This cone contains a series of aluminum wire coils which act as a filter through which the gases pass to the condenser. The center section of the crankcase is made of pressed steel, well ribbed, while the rear section is machined from a forging; this houses a double cam which operates the twenty valves.

The crankshaft is a one-piece forging, with ball bearing crank pins, upon which are machined, tempered and ground, the ball races. Vibration has been overcome at all engine speeds by the use of concentric weights which have the same diameter as the master rod big ends, and are attached opposite the crank pins to the crank cheeks. This system of balance has been instrumental in greatly increasing the all round efficiency of the engine.



Front View of the Hudson Engine

The connecting rods are machined from steel forgings, the big ends of the master rods are split to allow for the attachment of crank pins and ball bearings.

The cylinders are machined from one-piece forgings and have vanadium iron liners. These liners, as well as the pistons, are the only castings used in the Hudson engine.

Lubrication is effected by means of a gear pump which feeds oil to each piston, the surplus being returned to the tank. The amount of oil supplied to the engine is regulated by means of a lever.

The carburetor is of the floatless type, with no springs, and has two horizontal guillotine shutters. One of these is connected to a vertical valve which controls the flow of gasoline, and also the speed, while the other shutter, being independent in operation from the former, is used to correct the mixture.

Ignition is effected by means of two high-tension Bosch magnetos, which are driven at one and one-quarter crankshaft speed.

The Gallaudet D-4 Light Bomber Seaplane

The Gallaudet D-4 light bomber is a single Liberty engined seaplane with fuselage propeller, geared down f?. 5.

Three hours' fuel supply is carried in two tanks in the main pontoon, fed by anemometer driven gear pumps to service tank buried in top center section. Two cellular radiators of special design are carried in the top wings, to and from which the water is carried through the forward posts of the upper center section.

Gallaudet D-4 Light Bomber Seaplane

The armament consists of two Mark V bombs, carried under the bottom wings, and twin Lewis guns on double scarf mount, in the forward cockpit.

The crew consists of a pilot seated, just forward of center section, and a gunner in a forward cockpit. The two cockpits are close together.

The official scale weight, with crew, fuel, ordnance, and all equipment complete, ready for action, is 5430 lb.

Dimensions: Spread, 46 ft. 6 in.; Length, 33 ft.; Chord, 7 ft.; Gap, 7 ft.; Contour, R.A.F.15; Area, 612 sq. ft.

Results of official tests conducted by Lieut. E. F. Stone as pilot, and other naval officers as observers, are given herewith. The speeds are average of runs with and against wind over course on Narragansett Bay 8.53 miles long.

Speed with bombs	118½ m.p.h.	
Speed without bombs,	124½ m.p.h.	
Climb with bombs,	6000	ft in 10 min.
	8100	" " 15 "
Climb without bombs	7700	" " 10 "
Slowest landing measured	42.6 m.p.h.	
Slowest getaway measured	46 m.p.h.	

Flying 78 m.p.h., consumed 32 gal. in 120 min.

The Pentz Compass for Aircraft

The Pentz compass, the invention of which was brought about through Dr. James Bolton Pentz, of Staten Island, reading an article about a year ago by a Captain in the Royal (British) Air Force, who set forth the necessity of a compass that would show the aviator the horizontal and vertical lines of flight under all conditions. The Captain declared that frequently a pilot after a brush with the enemy found himself flying upside down, and often would travel miles behind the enemy lines before he realized the direction in which he was going. As a result many men and aircraft were lost.

This article started Dr. Pentz thinking, and after he applied some of the principles used in the existing compasses and several innovations of his own, these experiments finally resulted in the adoption of a float in a spherical container which supported a card, thus freeing the card from any direct connection with the container, thus satisfactorily isolating the card from all vibrations and the severe shock when landing. The float element in the compass was suggested by the Doctor's wife at the time he was working on the instrument, and credit is due her for one of its most novel elements.

Numerous tests have been made by experts with the result that the compass has been adopted by the United States Mail Service as part of its standard equipment, and is being used in the mail planes on all of their daily flights, also being installed in the service between New York and Chicago. The United States Army has installed these instruments in one-half dozen planes at each of their aviation training fields throughout the country, with the view in mind of adopting them as part of their standard equipment, it being recognized by the Army that a compass that does not spin is indispensable.

The compass is fixed in front of the pilot seat on the instrument board and takes the place of three instruments now in use. It indicates the direction in which the machine is moving, according to the points of the compass, the lateral incline of the plane, and the angle of climb and descent.

The compass weighs about 3.5 lb.; it consists of a glass globe fastened to an aluminum frame and bracket. Inside of the globe is the compass card, full-floated in kerosene and supported by a framework which is contained by a float. The oil is capable of withstanding a temperature of 40 deg. below zero before freezing.

In speaking of the new invention, Mr. Wm. Van Alen, who has taken up the marketing of the compass, said, that the Pentz compass has not only proven to be a remarkable instrument for aerial navigation, but should prove very valuable for marine work as well. A compass with a fixed pivot is subject to shock and vibration whether in use in aerial or marine navigation, which causes the card to rotate or oscillate according to the violence of the shock transmitted to the pivot supporting card. This shock is taken up by the air and liquid cushion, and the pivot's complete isolation from its container, by the Pentz compass. The shock on landing is considerable and in a short time tends to blunt the point of pivot in the instruments where the card is supported or attached to the container, impairing the card's sensitiveness and efficiency. This danger is done away with through Dr. Pentz's invention.

News of the Fortnight

General Mitchell, Director of M. A.

Major General William L. Kenly, Director of Military Aeronautics since the split from the Signal Corps, has been relieved from duty with the Air Service, discharged as a temporary Major General only, and ordered to report for duty to the Chief of Field Artillery, assuming his rank in the regular army as Colonel

Brig Gen William Mitchell, who was assistant chief of the Air Service to the A E F in charge of operations in the army zone until the armistice, and who then became chief of the Air Service in the Third Army of Occupation, will succeed General Kenly as Director of Military Aeronautics.

This change in Directors is officially described as part of the reduction of the Air Service to a peace time basis. After March 15 there are to be only two training fields and the personnel is to be cut down to the number needed for these two fields. So far as possible this personnel will be drawn from those officers and men who want to remain permanently in the service

L.-W.-F. Gets Mailplane Contract

Bids for changing and modifying twelve DeHaviland-4 airplanes and as many more up to sixty in lots of twelve, as the Postmaster may direct were opened Feb 26

Bidder	Price tender	Total
Curtiss Aeroplane & Motor Corp, Garden City N Y	$1,977	$23,700
Aircraft Eng Co, New York City N Y	3,484.87	41,815
Willeman Lewis Aircraft Co Newark N J	3,400	40,800
L. W F Eng. Corp, College Point N Y	(1) 998.50	11,958
	(2) 1,462	17,544
Continental Aircraft Co New York City, N Y	2,325	27,900
West Virginia Aircraft Co Wheeling W Va	1,850	21,000

The contract was awarded to the L.-W.-F. Engineering Co. Its alternative bid, $1,462—which will probably be accepted—includes new lines, the stretching and testing of all wires, and the substitution of a nickel steel landing device in lieu of the wooden one now used.

Captain Arter with Sperry

Capt Theodore Arter, who was stationed at Langley Field during the war as officer in charge of experimental flying, is now general manager of the Lawrence Sperry Aircraft Co.

Le Pere Machine in Fast Flight

Lieut Ernest E Harmon, A S, flying a Le Pere two seater fighter and day bomber, made on Feb 18 an exceedingly fast trip between Mineola, L. I, and Bolling Field, Washington, D C, when he covered the distance, about 235 miles, in 1 hr 25 min. His average speed was 168 m p h

The previous record between New York and Washington was 1 hr. and 37 min. established by Major Orker, A S, in January, when he flew to New York with Major-Gen W L Kenly in a De Haviland-4

Public Seaplane Service Station

A new venture in aviation is announced by Henri Amerman, attorney for a group of men headed by I M Uppercu, president of the Aeromarine Plane and Motor Co. It is proposed to build a public flying boat service station at 181st Street and the Hudson River (Fort Washington Point)

Mr Amerman stated that the venture is being projected merely to encourage water flying and the private ownership of air yachts. The station will be a hangar only. There is no intention of participation in passenger carrying lines or anything of that nature other than to sell planes and rent hangars

Talked to Seaplane 150 Miles Away

Secretary of the Navy Daniels talked on March 11 by radio telephone with Ensign Harry Fagenwater in a navy flying boat en route from Washington to Hampton Roads. Communication was established at a distance of more than 150 miles.

Civil Flying Licenses

The following licenses to fly civil aircraft in 1919 have been issued up to and including Feb 24 by the joint Army and Navy Board on Aeronautic Cognizance

License No.	Issued to	Address
117	The Lawrence Sperry Aircraft Co	Farmingdale L. I.
178	Dewey Airplane Company	Dewey, Oklahoma
301	Marjorie Stinson 122 King Ave	San Antonio Tex.
302	Theodore Hedlund	Boston Mass
303	Louis Gertson	Chicago Ill.
304	Baxter H Adams	Henderson Ky
305	David Gregg	Brookline Mass
306	Edwin K. Jaquith	Atlantic City N. J.
307	Curtiss Flying Station	Atlantic City N. J.
308	Walter Pack	San Francisco Cal.
309	Leon Richardson	Washington D. C.
310	W B Fitzpatrick Jr	Buffalo N. Y.
311	Walter T Varney	San Francisco Cal.
312	Clarke C Minter	Washington D. C.
313	W E Nightingale	Nantasket Mass
316	J Riley	Caro Mich.
320	Harry B Crewsdon	Chicago Ill.
321	Warren L. Baker	Providence R. I.
322	Allen P Bourdes	East Greenwich R. I.
323	John O'Mara Jr	Brooklyn N. Y.
324	Ed R Hutchinson	Elmira N. Y.
326	Curtiss Aeroplane & Motor Corp	New York N. Y.
327	B H Kendrick	Atlantic City N. J.
328	Prof Rexford C Lardner	Celoron N. Y.
330	Frank Bonar	Underwood Iowa
331	Charles T Mills	La Salle N. Y.
332	America Trans Oceanic Co (David H McCulloch)	N Y City
333	Frank Mills	Essington Pa.
335	Walter W Raub	Salem, Ohio
336	A W Snyder	Bolling Field D. C.
337	Howard A Fehalli	New York N. Y.
338	Melvin W Hodgdon	Somerville Mass.

Federal Air Legislation

President Wilson, in submitting to the House, Feb 26 recommendations of the National Advisory Committee for Aeronautics for legislation placing the licensing and regulation of aerial navigation in charge of the Department of Commerce, declared that he "fully approved the suggested legislation." Secretaries Baker, Daniels and Redfield also indorsed the proposal

The legislation would give the Department of Commerce authority to issue licenses for civilian operation of aircraft and provides an appropriation of $25,000 for the necessary expenses.

Cancellation of Contracts

Aircraft contracts totalling $460,000,000 have been canceled or suspended by the War Department since the signing of the armistice. A department statement said that 53 per cent of the total represented orders for engines and parts and 35 per cent for planes and parts

During the week ended Feb 7 about $2,000,000 worth of engines and planes were delivered, leaving orders still to be filled valued at $10,000,000. Outstanding orders for service planes on the day hostilities ceased aggregated $125,000,000 and up to Feb 7 about $114,000,000, or 91 per cent of these contracts, had been canceled. The outstanding orders on November 11 for service engines were $227,000,000, of which $193,000,000, or 85 per cent, have been canceled

U. S. Holds Altitude Record

America still holds the world's airplane altitude record with 28,900 ft, set Sept 18 last by Major R W Schroeder, A S, at Wilbur Wright Field, Dayton, Ohio

Since Jan 2 it had been believed that Captain Lang of the Royal Air Force had topped this climb by 1,600 ft. in reaching a height of 30,500 ft in England. On March 11, however, a cable message from the London *Graphic* to the authorities of the Aeronautical Exposition in Madison Square Garden said that a rereading of Captain Lang's instruments had fixed his altitude at 27,000 ft, leaving a clear margin in Major Schroeder's favor. The American made his climb in an American built Bristol airplane equipped with a 300 hp Hispano Suiza engine

1919

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ACCURACY *and* AUTHORITATIVE CONTENTS

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Enclosed please find $1.00, for which send me AVIATION AND AERONAUTICAL ENGINEERING for four months.

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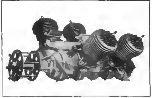
The W. B. B. Aero Motor



We are ready to fill single or quantity orders for this remarkable four cylinder, air-cooled 38 h.p., 130 pound motor.

Owing to the interest shown at the Aero Show and the production basis that such interest would warrant, we are reducing the price of this motor to

$550

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COMBINED COMPASS INCLINOMETER CLINIMETER

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